

766
LONGITUDE

MADE EASY,

FROM THE

MOON'S ALTITUDE ONLY.

By WILLIAM GARRARD.

L O N D O N:

Printed for the AUTHOR, by J. MOORE, No. 43,

DRURY-LANE.

M, DCC, LXXXVII.

15

LONGITUDE

MADE EASY



BY WILLIAM GARRARD

Printed for the Author, by J. MOORE, No. 10.

P R E F A C E.

THE Method of finding the Longitude from the Observed distance between the Sun and Moon, or the Moon and a known fixed Star, being Attended with so many Difficulties in making the Observations, but more particularly in the Calculations for deducing the true distance from the observed, that notwithstanding the pains which have been taken by the Conductors of the Nautical Ephemerics in preparing Tables for that purpose, *An easier and better Solution is yet a desideratum in the Science of Navigation.*

The following Method from the Moon's Altitude, being dependant on one Observation only, and the Calculation performed with such ease

P R E F A C E.

and expedition, induces the Author to hope it will meet the Approbation of the Public. — The annexed Tables are sufficient for Correcting the Moon's Altitude independant of any other; the Table of Refraction is the largest now extant; and the Table of Sines to every five Seconds is not to be met with in any other Book. — The Rules are laid down in such a Plain and Practical Manner, that those of the least practice in Navigation may follow them without difficulty, and although the method above mentioned is now become so universal, this will, nevertheless, be found of the utmost Service, as the Moon's Altitude alone may frequently be taken when Co-temporary Observations cannot be made.

TABLE I.

Height of the Eye in Feet.	Dip.	
	1	2
1	0	57
2	1	21
3	1	39
4	1	55
5	2	8
6	2	20
7	2	31
8	2	42
9	2	52
10	3	1
11	3	10
12	3	18
13	3	26
14	3	34
15	3	42
16	3	49
17	3	56
18	4	3
19	4	10
20	4	16
22	4	28
24	4	40
26	4	52
28	5	3
30	5	14
32	5	23
34	5	34
36	5	43
38	5	52
40	6	2
42	6	10
44	6	18
46	6	26
48	6	34
50	6	44
55	7	3
60	7	23
65	7	41
70	7	59
75	8	16
80	8	32
85	8	48

TABLE II. OF REFRACTION.

OF REFRACTION.											
Apparent Altitude.		Refraction.		Apparent Altitude.		Refraction.		Apparent Altitude.		Refraction.	
'	"	'	"	'	"	'	"	'	"	'	"
3	0	14	18	3	40	12'	28	4	20	11/	0
	1		15		41		25		21	10	58
	2		12		42		23		22		56
	3		9		43		20		23		54
	4		6		44		18		24		52
	5		3		45		16		25		50
	6		0		46		13		26		48
	7	13'	57		47		11		27		46
	8		54		48		8		28		44
	9		51		49		6		29		42
	10		48		50		4		30		40
	11		45		51		1		31		38
	12		42		52	11'	59		32		37
	13		39		53		57		33		35
	14		36		54		55		34		33
	15		33		55		52		35		31
	16		31		56		50		36		29
	17		28		57		48		37		27
	18		25		58		46		38		26
	19		22		59		43		39		24
	20		20	4	0		41		40		22
	21		17		1		39		41		20
	22		14		2		37		42		19
	23		11		3		35		43		17
	24		9		4		32		44		15
	25		6		5		30		45		13
	26		3		6		28		46		11
	27		1		7		26		47		10
	28	12'	58		8		24		48		8
	29		55		9		22		49		6
	30		53		10		20		50		5
	31		50		11		18		51		3
	32		48		12		16		52		1
	33		45		13		14		53		0
	34		43		14		12		54	9'	58
	35		40		15		10		55		56
	36		38		16		7		56		55
	37		35		17		5		57		53
	38		33		18		3		58		51
	39		30		19		1		59		50

TABLE II. OF REFRACTION.

Apparent Altitude.	Refract.	Apparent Altitude.	Refract.	Apparent Altitude.	Refract.
0	1	0	1	0	1
5	0	6	20	8	0
2	45	22	7	3	27
4	42	24	56	6	25
6	39	26	54	9	23
8	36	28	52	12	20
10	32	30	50	15	18
12	29	32	48	18	16
14	26	34	46	21	14
16	23	36	44	24	12
18	21	38	42	27	10
20	18	40	40	30	8
22	15	42	38	33	6
24	12	44	36	36	4
26	9	46	34	39	2
28	6	48	32	42	0
30	3	50	30	45	58
32	0	52	28	48	56
34	8	54	26	51	54
36	56	56	24	54	52
38	52	58	22	57	50
40	50	7	20	9	49
42	47	3	17	3	47
44	44	6	14	6	45
46	42	9	11	9	43
48	39	12	9	12	41
50	37	15	6	15	40
52	34	18	3	18	38
54	32	21	1	21	36
56	29	24	6	24	34
58	27	27	58	27	32
6	24	30	56	30	31
2	22	33	53	33	30
4	20	36	48	36	28
6	17	39	46	39	26
8	15	42	43	42	25
10	12	45	41	45	23
12	10	48	38	48	22
14	8	51	36	51	20
16	5	54	34	54	19
18	3	57	31	57	17

TABLE II. OF REFRACTION.

Apparent Altitude.	Refract.	Apparent Altitude.	Refract.	Apparent Altitude.	Refract.
° ' "	' "	° ' "	' "	° ' "	' "
10 0	5 15	17 0	3 5	31 0	1 35
10 10	11	17 15	3 3	31 30	34
20 0	6	30 0	0	32 0	32
30 0	1	45 0	2 57	30 30	30
40 0	4 56	18 0	54	33 0	28
50 0	52	15 0	51	30 30	26
11 0	47	30 0	49	34 0	25
10 10	43	45 0	47	30 30	24
20 0	40	19 0	45	35 0	22
30 0	36	15 0	42	30 30	20
40 0	32	30 0	40	36 0	19
50 0	29	45 0	38	30 30	18
12 0	25	20 0	36	37 0	16
10 10	21	15 0	34	30 30	15
20 0	18	30 0	32	38 0	13
30 0	15	45 0	30	30 30	12
40 0	11	21 0	28	39 0	11
50 0	8	15 0	26	30 30	10
13 0	4	30 0	24	40 0	8
10 10	1	45 0	22	30 30	7
20 0	3 58	22 0	21	41 0	6
30 0	55	15 0	19	30 30	5
40 0	52	30 0	17	42 0	4
50 0	49	45 0	16	30 30	3
14 0	46	23 0	14	43 0	1
10 10	43	30 0	11	30 30	0
20 0	40	24 0	8	44 0	0 59
30 0	38	30 0	5	30 30	58
40 0	35	25 0	2	45 0	57
50 0	33	30 0	1 59	30 30	56
15 0	31	26 0	57	46 0	55
10 10	28	30 0	54	30 30	54
20 0	26	27 0	52	47 0	53
30 0	24	30 0	50	30 30	53
40 0	21	28 0	48	48 0	52
50 0	19	30 0	45	30 30	51
16 0	17	29 0	43	49 0	50
15 10	14	30 0	41	30 30	49
30 0	11	30 0	39	50 0	48
45 0	8	30 0	37	30 30	48

TABLE II. OF REFRACTION.

Apparent Altitude.	Refract.	Apparent Altitude.	Refract.	Apparent Altitude.	Refract.
0 1	1 1	0 1	1 1	0 1	1 1
51 0	47	61 0	32	76 0	14
30	46	62 0	31	77 0	13
52 0	45	63 0	30	78 0	12
30	44	64 0	29	79 0	11
53 0	43	65 0	27	80 0	10
80	43	66 0	26	81 0	9
54 0	42	67 0	24	82 0	8
30	41	68 0	23	83 0	7
55 0	40	69 0	22	84 0	6
30	40	70 0	21	85 0	5
56 0	39	71 0	20	86 0	4
30	37	72 0	19	87 0	3
57 0	36	73 0	18	88 0	2
30	34	74 0	17	89 0	1
58 0	33	75 0	15		
30					
59 0					
30					
60 0					
30					
61 0					
30					
62 0					
30					
63 0					
30					
64 0					
30					
65 0					
30					
66 0					
30					
67 0					
30					
68 0					
30					
69 0					
30					
70 0					
30					
71 0					
30					
72 0					
30					
73 0					
30					
74 0					
30					
75 0					
30					

TABLE III.

Reduction of the Horizon Parallax.

Lat.	54	56	58	60
0	0 . 2	0 . 2	0 . 2	0 . 2
6	1	1	1	1
12	1	1	1	2
18	2	2	3	3
24	3	3	4	4
30	5	5	5	5
36	6	7	7	7
42	8	8	8	9
48	9	10	10	10
54	11	11	11	12
60	12	12	13	13
66	13	13	14	14
72	13	14	14	15
78	14	14	15	15
84	14	15	16	16
90				

TABLE IV. Reduction of the Horizon Parallax.

Altitude.	Log.	Altitude.	Log.	Altitude.	Log.
0		0		0	
1 10	8 2271	8 0	8 2230	14 50	8 2125
20	8 2271	10	8 2228	15 0	8 2121
30	8 2271	20	8 2226	10	8 2118
40	8 2270	30	8 2224	20	8 2115
50	8 2270	40	8 2222	30	8 2111
2 0	8 2269	50	8 2220	40	8 2108
10	8 2269	9 0	8 2218	50	8 2104
20	8 2268	10	8 2216	16 0	8 2100
30	8 2268	20	8 2214	10	8 2097
40	8 2267	30	8 2212	20	8 2093
50	8 2267	40	8 2210	30	8 2089
3 0	8 2266	50	8 2208	40	8 2086
10	8 2265	10 0	8 2206	50	8 2082
20	8 2265	10	8 2203	17 0	8 2078
30	8 2264	20	8 2201	10	8 2074
40	8 2263	30	8 2199	20	8 2070
50	8 2262	40	8 2196	30	8 2066
4 0	8 2261	50	8 2194	40	8 2062
10	8 2261	11 0	8 2191	50	8 2058
20	8 2260	10	8 2189	18 0	8 2054
30	8 2259	20	8 2187	10	8 2050
40	8 2258	30	8 2184	20	8 2046
50	8 2257	40	8 2181	30	8 2042
5 0	8 2255	50	8 2179	40	8 2037
10	8 2254	12 0	8 2177	50	8 2033
20	8 2253	10	8 2174	19 0	8 2029
30	8 2252	20	8 2171	10	8 2024
40	8 2251	30	8 2168	20	8 2020
50	8 2250	40	8 2165	30	8 2016
6 0	8 2248	50	8 2162	40	8 2011
10	8 2247	13 0	8 2159	50	8 2006
20	8 2245	10	8 2156	20 0	8 2002
30	8 2244	20	8 2153	10	8 1998
40	8 2243	30	8 2150	20	8 1993
50	8 2241	40	8 2147	30	8 1988
7 0	8 2240	50	8 2144	40	8 1983
10	8 2238	14 0	8 2141	50	8 1978
20	8 2236	10	8 2138	21 0	8 1974
30	8 2235	20	8 2135	10	8 1969
40	8 2233	30	8 2131	20	8 1964
50	8 2231	40	8 2128	30	8 1959

TABLE IV. Reduction of the Horizon Parallax.

Altitude.		Log.	Altitude.		Log.	Altitude.		Log.
0	1		0	1		0	1	
21	40	8 1954	28	20	8 1718	35	0	8 1406
	50	8 1949		30	8 1711		10	8 1397
22	0	8 1944		40	8 1704		20	8 1388
	10	8 1939		50	8 1697		30	8 1379
	20	8 1933	29	0	8 1690		40	8 1370
	30	8 1928		10	8 1683		50	8 1361
	40	8 1923		20	8 1676	36	0	8 1352
	50	8 1918		30	8 1669		10	8 1342
23	0	8 1912		40	8 1662		20	8 1333
	10	8 1907		50	8 1655		30	8 1324
	20	8 1902	30	0	8 1647		40	8 1314
	30	8 1896		10	8 1640		50	8 1305
	40	8 1891		20	8 1632	37	0	8 1296
	50	8 1885		30	8 1625		10	8 1286
24	0	8 1879		40	8 1618		20	8 1276
	10	8 1874		50	8 1610		30	8 1267
	20	8 1868	31	0	8 1603		40	8 1257
	30	8 1862		10	8 1595		50	8 1247
	40	8 1857		20	8 1587	38	0	8 1237
	50	8 1851		30	8 1580		10	8 1227
25	0	8 1845		40	8 1572		20	8 1218
	10	8 1839		50	8 1564		30	8 1207
	20	8 1833	32	0	8 1556		40	8 1197
	30	8 1827		10	8 1548		50	8 1187
	40	8 1821		20	8 1540	39	0	8 1177
	50	8 1815		30	8 1532		10	8 1167
26	0	8 1809		40	8 1524		20	8 1156
	10	8 1802		50	8 1516		30	8 1146
	20	8 1796	33	0	8 1508		40	8 1136
	30	8 1790		10	8 1500		50	8 1125
	40	8 1784		20	8 1491	40	0	8 1115
	50	8 1777		30	8 1483		10	8 1104
27	0	8 1771		40	8 1475		20	8 1093
	10	8 1764		50	8 1466		30	8 1083
	20	8 1758	34	0	8 1458		40	8 1072
	30	8 1751		10	8 1450		50	8 1061
	40	8 1745		20	8 1441	41	0	8 1050
	50	8 1738		30	8 1432		10	8 1039
28	0	8 1731		40	8 1423		20	8 1028
	10	8 1725		50	8 1415		30	8 1017

TABLE IV. Reduction of the Horizon Parallax.

Altitude.	Log.	Altitude.	Log.	Altitude.	Log.
° /		° /		° /	
41 40	8 1005	48 20	8 0499	55 0	7 9858
50	8 0994	30	8 0485	10	7 9846
42 0	8 0983	40	8 0470	20	7 9822
10	8 0971	50	8 0456	30	7 9803
20	8 0960	49 0	8 0441	40	7 9785
30	8 0948	10	8 0427	50	7 9766
40	8 0937	20	8 0412	56 0	7 9748
50	8 0925	30	8 0397	10	7 9729
43 0	8 0913	40	8 0383	20	7 9710
10	8 0902	50	8 0368	30	7 9691
20	8 0890	50 0	8 0353	40	7 9672
30	8 0878	10	8 0338	50	7 9653
40	8 0866	20	8 0322	57 0	7 9633
50	8 0854	30	8 0307	10	7 9614
44 0	8 0841	40	8 0292	20	7 9594
10	8 0829	50	8 0276	30	7 9574
20	8 0817	51 0	8 0261	40	7 9554
30	8 0804	10	8 0245	50	7 9534
40	8 0792	20	8 0229	58 0	7 9514
50	8 0780	30	8 0214	10	7 9494
45 0	8 0767	40	8 0198	20	7 9473
10	8 0754	50	8 0182	30	7 9453
20	8 0741	52 0	8 0165	40	7 9432
30	8 0729	10	8 0149	50	7 9411
40	8 0716	20	8 0133	59 0	7 9390
50	8 0703	30	8 0117	10	7 9369
46 0	8 0690	40	8 0100	20	7 9348
10	8 0677	50	8 0083	30	7 9327
20	8 0663	53 0	8 0066	40	7 9305
30	8 0650	10	8 0050	50	7 9284
40	8 0637	20	8 0033	60 0	7 9262
50	8 0623	30	8 0016	10	7 9240
47 0	8 0610	40	7 9999	20	7 9218
10	8 0596	50	7 9982	30	7 9195
20	8 0583	54 0	7 9964	40	7 9173
30	8 0567	10	7 9947	50	7 9150
40	8 0554	20	7 9929	61 0	7 9128
50	8 0541	30	7 9912	10	7 9105
48 0	8 0527	40	7 9894	20	7 9082
10	8 0513	50	7 9876	30	7 9059

TABLE IV. Reduction of the Horizon Parallax.

Altitude.	Log.	Altitude.	Log.	Altitude.	Log.
61 40	7 9035	68 20	7 7945	75 36	7 6220
50	7 9012	30	7 7913	48	7 6169
62 0	7 8988	40	7 7881	76 0	7 6109
10	7 8964	50	7 7848	15	7 6032
20	7 8940	69 0	7 7815	30	7 5953
30	7 8916	10	7 7782	45	7 5874
40	7 8892	20	7 7749	77 0	7 5793
50	7 8867	30	7 7715	15	7 5710
63 0	7 8842	40	7 7681	30	7 5625
10	7 8818	50	7 7648	45	7 5539
20	7 8793	70 0	7 7613	78 0	7 5451
30	7 8767	10	7 7578	15	7 5361
40	7 8742	20	7 7543	30	7 5269
50	7 8716	30	7 7507	45	7 5174
64 0	7 8690	40	7 7471	79 0	7 5078
10	7 8664	50	7 7435	20	7 4946
20	7 8638	71 0	7 7398	40	7 4810
30	7 8612	10	7 7362	80 0	7 4669
40	7 8585	20	7 7324	30	7 4448
50	7 8559	30	7 7287	81 0	7 4217
65 0	7 8532	40	7 7249	30	7 3969
10	7 8504	50	7 7211	82 0	7 3708
20	7 8477	72 0	7 7172	30	7 3429
30	7 8449	12	7 7125	83 0	7 3131
40	7 8421	24	7 7077	30	7 2811
50	7 8393	36	7 7029	84 0	7 2464
66 0	7 8366	48	7 6981	30	7 2088
10	7 8337	73 0	7 6931	85 0	7 1675
20	7 8308	12	7 6882	30	7 1218
30	7 8279	24	7 6831	86 0	7 0708
40	7 8250	36	7 6780	30	7 0129
50	7 8220	48	7 6728	87 0	6 9460
67 0	7 8191	74 0	7 6675	30	6 8669
10	7 8161	12	7 6622	88 0	6 7700
20	7 8131	24	7 6568	30	6 6451
30	7 8100	36	7 6514	89 0	6 4691
40	7 8070	48	7 6458	30	6 1680
50	7 8039	75 0	7 6402		
68 0	7 8008	12	7 6345		
10	7 7976	24	7 6287		

TABLE V.

Horizon. Parallax.	Log. Diff.	Horizon. Parallax.	Log. Diff.	Horizon. Parallax.	Log. Diff.
53 0	— 0392	54 45	— 0251	56 30	— 0114
3	0388	48	0247	33	0110
6	0384	51	0243	36	0106
9	0380	54	0239	39	0102
12	0376	57	0235	42	0098
15	0371	55 0	0231	45	0094
18	0367	3	0227	48	0090
21	0363	6	0223	51	0086
24	0359	9	0219	54	0083
27	0355	12	0215	57	0079
30	0351	15	0211	57 0	0076
33	0347	18	0207	3	0072
36	0343	21	0203	6	0069
39	0339	24	0199	9	0065
42	0335	27	0195	12	0061
45	0331	30	0191	15	0057
48	0327	33	0187	18	0053
51	0323	36	0183	21	0049
54	0319	39	0179	24	0046
57	0315	42	0175	27	0042
54 0	0310	45	0172	30	0038
3	0306	48	0168	33	0034
6	0302	51	0164	36	0030
9	0298	54	0160	39	0027
12	0294	57	0156	42	0023
15	0291	56 0	0152	45	0019
18	0287	3	0148	48	0015
21	0283	6	0144	51	0011
24	0279	9	0141	54	0008
27	0275	12	0137	57	x 0004
30	0270	15	0134	58 0	0000
33	0266	18	0130	3	0004
36	0262	21	0126	6	0008
39	0258	24	0122	9	0011
42	0254	27	0118	12	0014

TABLE V.

Horizon. Parallax.	Log.	Horizon. Parallax.	Log. Diff.	Horizon. Parallax.	Log. Diff.
58 15	x 0018	59 9	x 0085	60 5	x 0153
18	0022	12	0089	10	0159
21	0026	15	0092	15	0165
24	0029	13	0096	20	0171
27	0033	21	0099	25	0177
30	0037	24	0103	30	0183
33	0041	27	0107	35	0189
36	0045	30	0111	40	0195
39	0048	33	0115	45	0201
42	0052	36	0118	50	0207
45	0056	39	0122	55	0213
48	0059	42	0126	61 0	0219
51	0063	45	0129		
54	0067	48	0133		
57	0070	51	0137		
59 0	0074	54	0140		
3	0078	57	0144		
6	0081	60 0	0147		

TABLE VI. LOGRITHMIC SINES.

"	1	2	3	4	5
0	6 4637	6 7648	6 9408	7 0658	7 1627
5	6 4985	6 7825	6 9427	7 0747	7 1699
10	6 5307	6 7995	6 9643	7 0835	7 1769
15	6 5606	6 8159	6 9756	7 0921	7 1839
20	6 5887	6 8317	6 9866	7 1005	7 1907
25	6 6150	6 8469	6 9973	7 1088	7 1975
30	6 6393	6 8617	7 0078	7 1169	7 2041
35	6 6633	6 8760	7 0180	7 1249	7 2106
40	6 6856	6 8897	7 0280	7 1327	7 2171
45	6 7068	6 9051	7 0378	7 1404	7 2234
50	6 7270	6 9160	7 0473	7 1480	7 2296
55	6 7463	6 9286	7 0566	7 1554	7 2358
"	6	7	8	9	10
0	7 2419	7 3088	7 3668	7 4180	7 4637
5	7 2479	7 3140	7 3713	7 4220	7 4673
10	7 2538	7 3190	7 3758	7 4259	7 4709
15	7 2596	7 3241	7 3802	7 4299	7 4744
20	7 2654	7 3290	7 3845	7 4338	7 4780
25	7 2710	7 3339	7 3889	7 4376	7 4815
30	7 2766	7 3388	7 3931	7 4414	7 4849
35	7 2822	7 3436	7 3974	7 4452	7 4883
40	7 2876	7 3483	7 4016	7 4490	7 4918
45	7 2930	7 3530	7 4057	7 4527	7 4951
50	7 2984	7 3577	7 4099	7 4564	7 4985
55	7 3036	7 3623	7 4139	7 4601	7 5018
"	11	12	13	14	15
0	7 5051	7 5429	7 5777	7 6099	7 6393
5	7 5084	7 5459	7 5804	7 6124	7 6422
10	7 5116	7 5489	7 5832	7 6150	7 6446
15	7 5149	7 5519	7 5859	7 6175	7 6470
20	7 5181	7 5548	7 5887	7 6201	7 6494
25	7 5213	7 5577	7 5914	7 6226	7 6517
30	7 5244	7 5606	7 5941	7 6251	7 6541
35	7 5276	7 5635	7 5967	7 6276	7 6564
40	7 5307	7 5664	7 5994	7 6301	7 6587
45	7 5338	7 5692	7 6020	7 6325	7 6610
50	7 5368	7 5721	7 6047	7 6350	7 6633
55	7 5399	7 5749	7 6073	7 6374	7 6656

TABLE VI. Logarithmic Sines.

	16	17	18	19	20
0	7 6678	7 6942	7 7190	7 7425	7 7648
5	7 6701	7 6963	7 7210	7 7444	7 7666
10	7 6723	7 6984	7 7230	7 7463	7 7684
15	7 6746	7 7003	7 7250	7 7482	7 7701
20	7 6768	7 7026	7 7270	7 7500	7 7719
25	7 6790	7 7047	7 7289	7 7519	7 7737
30	7 6812	7 7068	7 7309	7 7538	7 7755
35	7 6834	7 7088	7 7328	7 7556	7 7772
40	7 6856	7 7108	7 7348	7 7575	7 7790
45	7 6877	7 7129	7 7367	7 7593	7 7807
50	7 6900	7 7150	7 7387	7 7611	7 7825
55	7 6920	7 7170	7 7406	7 7629	7 7842
	21	22	23	24	25
0	7 7859	7 8061	7 8255	7 8439	7 8617
5	7 7877	7 8078	7 8270	7 8454	7 8691
10	7 7896	7 8094	7 8286	7 8469	7 8645
15	7 7911	7 8111	7 8301	7 8484	7 8660
20	7 7928	7 8127	7 8317	7 8499	7 8674
25	7 7945	7 8143	7 8332	7 8514	7 8688
30	7 7962	7 8159	7 8348	7 8529	7 8703
35	7 7978	7 8175	7 8363	7 8544	7 8717
40	7 7995	7 8191	7 8379	7 8558	7 8731
45	7 8012	7 8207	7 8394	7 8573	7 8745
50	7 8028	7 8223	7 8409	7 8588	7 8759
55	7 8045	7 8239	7 8424	7 8602	7 8773
	26	27	28	29	30
0	7 8787	7 8951	7 9109	7 9261	7 9408
5	7 8801	7 8964	7 9122	7 9274	7 9420
10	7 8815	7 8978	7 9135	7 9286	7 9432
15	7 8829	7 8991	7 9147	7 9298	7 9444
20	7 8842	7 9004	7 9160	7 9311	7 9456
25	7 8856	7 9017	7 9173	7 9323	7 9468
30	7 8870	7 9031	7 9186	7 9335	7 9480
35	7 8883	7 9044	7 9198	7 9348	7 9492
40	7 8897	7 9057	7 9211	7 9359	7 9504
45	7 8910	7 9070	7 9224	7 9372	7 9516
50	7 8924	7 9083	7 9236	7 9384	7 9527
55	7 8937	7 9096	7 9249	7 9396	7 9539

TABLE VI. Logarithmic Sines.

	31	32	33	34	35
0	7 9551	7 9689	7 9822	7 9952	8 0078
5	7 9562	7 9700	7 9833	7 9963	8 0088
10	7 9574	7 9711	7 9844	7 9973	8 0098
15	7 9586	7 9722	7 9855	7 9984	8 0109
20	7 9597	7 9734	7 9866	7 9994	8 0119
25	7 9609	7 9745	7 9877	8 0005	8 0129
30	7 9620	7 9756	7 9888	8 0015	8 0139
35	7 9632	7 9767	7 9898	8 0026	8 0150
40	7 9643	7 9778	7 9909	8 0036	8 0160
45	7 9655	7 9789	7 9920	8 0047	8 0170
50	7 9666	7 9800	7 9931	8 0057	8 0180
55	7 9677	7 9811	7 9941	8 0068	8 0190
	36	37	38	39	40
0	8 0200	8 0319	8 0435	8 0548	8 0658
5	8 0210	8 0329	8 0445	8 0557	8 0667
10	8 0220	8 0339	8 0454	8 0566	8 0676
15	8 0230	8 0348	8 0463	8 0576	8 0685
20	8 0240	8 0358	8 0473	8 0585	8 0694
25	8 0250	8 0368	8 0482	8 0594	8 0703
30	8 0260	8 0377	8 0491	8 0603	8 0712
35	8 0270	8 0387	8 0501	8 0612	8 0721
40	8 0280	8 0397	8 0511	8 0621	8 0730
45	8 0290	8 0406	8 0519	8 0631	8 0738
50	8 0300	8 0416	8 0529	8 0640	8 0747
55	8 0309	8 0425	8 0539	8 0649	8 0756
	41	42	43	44	45
0	8 0765	8 0870	8 0972	8 1072	8 1169
5	8 0774	8 0878	8 0980	8 1080	8 1177
10	8 0783	8 0887	8 0989	8 1088	8 1185
15	8 0791	8 0895	8 0997	8 1096	8 1193
20	8 0800	8 0904	8 1005	8 1104	8 1201
25	8 0809	8 0913	8 1014	8 1113	8 1209
30	8 0818	8 0921	8 1022	8 1121	8 1217
35	8 0826	8 0930	8 1030	8 1129	8 1225
40	8 0835	8 0938	8 1039	8 1137	8 1233
45	8 0844	8 0947	8 1047	8 1145	8 1241
50	8 0852	8 0955	8 1056	8 1153	8 1249
55	8 0862	8 0963	8 1063	8 1161	8 1257

TABLE VI. Logarithmic Sines.

	46	47	48	49	50
0	8 1265	8 1338	8 1450	8 1539	8 1627
5	8 1273	8 1366	8 1457	8 1546	8 1634
10	8 1280	8 1373	8 1465	8 1554	8 1641
15	8 1288	8 1381	8 1472	8 1561	8 1648
20	8 1296	8 1388	8 1480	8 1569	8 1656
25	8 1304	8 1396	8 1487	8 1576	8 1663
30	8 1311	8 1404	8 1495	8 1583	8 1670
35	8 1319	8 1412	8 1502	8 1590	8 1677
40	8 1327	8 1419	8 1509	8 1598	8 1684
45	8 1335	8 1427	8 1517	8 1605	8 1691
50	8 1343	8 1434	8 1524	8 1612	8 1699
55	8 1350	8 1442	8 1532	8 1620	8 1706
	51	52	53	54	55
0	8 1713	8 1797	8 1880	8 1961	8 2041
5	8 1720	8 1804	8 1887	8 1968	8 2047
10	8 1727	8 1811	8 1893	8 1974	8 2054
15	8 1734	8 1818	8 1900	8 1981	8 2060
20	8 1741	8 1825	8 1907	8 1988	8 2067
25	8 1748	8 1832	8 1914	8 1994	8 2073
30	8 1755	8 1839	8 1920	8 2001	8 2080
35	8 1762	8 1846	8 1927	8 2007	8 2087
40	8 1769	8 1852	8 1934	8 2014	8 2093
45	8 1776	8 1859	8 1940	8 2021	8 2100
50	8 1783	8 1866	8 1948	8 2028	8 2106
55	8 1790	8 1873	8 1954	8 2034	8 2112
	56	57	58	59	60
0	8 2119	8 2196	8 2271	8 2346	8 2419
5	8 2125	8 2202	8 2278	8 2352	8 2425
10	8 2132	8 2208	8 2284	8 2358	8 2431
15	8 2138	8 2215	8 2290	8 2364	8 2437
20	8 2145	8 2221	8 2296	8 2370	8 2443
25	8 2151	8 2227	8 2302	8 2376	8 2449
30	8 2158	8 2234	8 2309	8 2382	8 2455
35	8 2164	8 2240	8 2315	8 2388	8 2461
40	8 2170	8 2246	8 2321	8 2394	8 2467
45	8 2177	8 2253	8 2327	8 2400	8 2473
50	8 2183	8 2259	8 2333	8 2406	8 2479
55	8 2189	8 2265	8 2339	8 2413	8 2485

PROBLEM I.

FROM the latitude and longitude by account, the hour of observation by the meridian of the place of observation, and the Moon's observed altitude to find her true altitude by the tables.

R U L E Ist.

WRITE down your observed altitude, and under it the dip. for the number of feet above the surface taken from Tab. I. with the sign,—and correct it by subtraction.

II. **W**ITH the corrected altitude take out the refraction from Tab. II. with the sign,—and correct a second time by subtraction.

III. **T**URN the longitude by account into time, and if it is east subtract it from the given time, the difference will be the time at Greenwich; but if is west, it must be added to the given time.

IV. **W**ITH this corrected time, take out the Moon's horizontal parallax from the ephemeris.

V. **W**ITH the given latitude and horizontal parallax enter Tab. III. and take out the correction, which must always be subtracted from the horizontal parallax given in the ephemeris.

VI. **W**ITH the altitude corrected for dip. and refraction enter Tab. IV. and take out the logarithm; and with the horizontal parallax corrected enter Tab. V. and take

P R O B L E M I.

take out the logarithm with its sign, if the sign is + the two logs must be added; but if it is less or — it must be subtracted.

VII. WITH the sum or difference of the two logarithms enter Tab. VI. of sines, and take out the minutes and seconds corresponding thereto and place it under the altitude last corrected, and add; the sum is the altitude of the Moon's lower limb three times corrected.

VIII. WITH the altitude last corrected, re-enter Tab. IV. and repeat the operation as in Rule the 7th; and add the minutes and seconds to the altitude corrected for dip, and refraction, the sum will be the true altitude of the Moon's lower limb.

IX. WITH the time used in the 4th Rule, take out the Moon's semi-diameter from the ephemeris and add it to the true altitude of the lower limb, the sum is the true altitude of the Moon's centre.

EXAMPLE.

EXAMPLE.

March 5th, 1784, in latitude $51^{\circ}29'.0''$ N. longitude nearly the same as at Greenwich, the altitude of the moon's lower limb was observed $36^{\circ}46'.45''$. Required the true altitude?

At 8h.18'.50" app. time. Obs. altitude $36^{\circ}46'.45''$
 being a true horizon, dip. $0^{\circ}0'.0''$
 Refraction — $1'.17''$

Altitude corrected for dip and refraction $36^{\circ}45'.28''$

Horizontal parallax $54'.41''$
 Cor. from table III. — 8 Log f. IV. 8.1310 $36^{\circ}45'.28''$

$54'.33$ Log f. V. — 0266

8.1044 li. $+43'.43''$

Altitude three times corrected $37^{\circ}29'.11''$

Log from IV. 8.1266

Log from V. — 0266

8.1000 line $+43'.17''$

True altitude of moon's lower limb $37^{\circ}28'.45''$

Semi-diameter and Augmentation $+15'.04''$

True altitude of the moon's centre $37^{\circ}43'.49''$

B

PROB.

P R O B L E M II.

From the latitude of the place, the longitude by account, the moon's observed altitude, and the time by the meridian of the place of observation, to find the true longitude.

R U L E S.

1st. Find the true altitude of the moon's center by problem 1st.

2d. With the time used in rule the fourth of problem 1st. take out the moon's declination correctly from the ephemeris.

3d. Take the complement of the latitude, the complement of the altitude, and the moon's distance from the pole, add them together and take half their sum; from the half sum subtract the co. altitude, and call it remainder.

4th. Take the complement arithmetical of the co. sine of the latitude, the complement arithmetical of the sine of the moon's distance from the pole, the log. sine of half the sum, and the log. sine of the remainder, add these four logarithms together, half the sum is the co. sine of half the moon's distance in right ascension from the meridian; double it and call it the horary angle.

5th. Take the sun's right ascension from the ephemeris in time for the last noon at the place of observation, and thereto add the time of observation; turn the sum into degrees and minutes by multiplying by 15, and it will be the right ascension of the mid-heaven.

P R O B L E M II.

6th. If the moon is not come to the meridian, add the horary angle to the right ascension of the mid-heaven, but if it is past the meridian, let them be subtracted; the sum, or difference, will be the moon's right ascension at the place of observation.

7th. Seek in the ephemeris in the column of right ascensions of the moon for the given day, and write out the two nearest, whether at noon or midnight, or at midnight and noon; take the difference of the first and second, also the difference of the first and the moon's right ascension above found—then say,

As the first remainder is to 12 hours,

So is the second remainder to the true Greenwich time.

8th. The difference of the time of observation, and true Greenwich time, is the difference of longitude in time, which multiplied by 15, is the true longitude either east or west; if the Greenwich time is greatest, the longitude is west, if less it is east.

Time of observation 3h. 13. 50
Sun's right ascension 23. 8. 11

7. 27. 11
6

22. 31. 53
5

111. 47. 45
41. 52. 04

123. 42. 42
Moon's right ascension

E X A M-

EXAMPLE.

March 5th, 1784, in latitude $51^{\circ}.29'$ N. the longitude nearly the same as at Greenwich, the true altitude of the moon's center before her meridian was $37^{\circ}.48'.49''$, the time of observation being $8h.18'.50''$ apparent time: Required the true longitude?

1st. for the moon's dec. $\left\{ \begin{array}{l} \text{noon } 13^{\circ}.29' \\ \text{midnight } 10^{\circ}.51' \end{array} \right\}$ Diff. $2^{\circ}.38'$

12h $2^{\circ}.38' = 8h.18'.50'' = 1^{\circ}.49'.27''$
 $13^{\circ}.29'.00$

Moon's declination. $11^{\circ}.39'.33$

0.00005 Sine co. arithmetical $78.20.27$ Polar distance.
 0.20569 Sine co. arithmetical $38.31.00$ Co. latitude.
 Co. altitude $52.16.11$

2) $169.07.38$

9.99804 Sine $\frac{1}{2}$ sum $84.133.49$

9.77775 Sine remainder $82.17.28$

2) 10.94058

9.97926 Co. sine $20^{\circ}.57'.32''$

$41^{\circ}.55'.04$ horary angle

Time of observation $8h.18.50$
 Sun's right ascension $23.8.21$

$7.27.11$

3

$22.21.33$

5

$111.47.45$

$41.55.04$

Moon's right ascen. $153.42.49$

At

E X A M P L E.

Moon's right ascension.

At noon $149^{\circ}.52'.00''$ — $149^{\circ}.52'.00''$

At midnight $155.26.00$ — $153.42.49$

$5.34.00$ — $3.50.49$

As $5^{\circ}.34'.0''$ is to 12h. so is $3^{\circ}.50'.49''$ to 8h.17.25

Time of observation $8.18.50$

Diff. of longitude in Time $0.1.25$
 15

True longitude west $0.21.15$

But the long. of the place of obs. was }
 known to be } $0.0.52$ W.

The Error is $0.0.33$

Which in this latitude is equal to $5\frac{1}{2}$ miles.

N. B. In this method of determining the longitude care should be taken in computing the moon's declination when it is very small either north or south, on account of the quickness of her motion in declination at that time.

F I N I S.

EXAMPLE

Moon's right ascension.

At noon $140^{\circ} 52' 00'' - 140^{\circ} 52' 00''$
At midnight $155^{\circ} 26' 00'' - 155^{\circ} 26' 00''$

$2^{\circ} 34' 00'' - 2^{\circ} 34' 00''$

$2^{\circ} 34' 00''$ is to $15^{\circ} 50' 40''$ as $15^{\circ} 50' 40''$ is to $15^{\circ} 50' 40''$

Time of observation $8^{\circ} 18' 50''$

Dir. of longitude in Time $0^{\circ} 1' 25''$

15

Time longitude west $0^{\circ} 21' 15''$

But the long. of the place of obs. was $0^{\circ} 0' 52''$ W.

The Error is $0^{\circ} 0' 23''$

Which in this latitude is equal to $2\frac{1}{2}$ miles.

N. B. In this method of determining the longitude care should be taken in comparing the moon's declination when it is very small either north or south, on account of the quickness of her motion in declination at that time.

FINIS